

10/520889

DT12 Rec'd PCT/PTO 11 JAN 2005

APPLICATION FOR
UNITED STATES LETTERS PATENT
SPECIFICATION

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Title of the Invention: SEPARATION ADJUSTMENT CIRCUIT

10/520889

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DESCRIPTION

SEPARATION ADJUSTMENT CIRCUIT5 **Technical Field**

The present invention relates to a separation adjustment circuit for increasing the separation degree between a right signal and a left signal in a stereo receiver.

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Background Art

Fig. 1 shows a conventional stereo receiver.

As shown in Fig. 1, a stereo receiver 70 comprises an antenna 71, a front end part 72 for implementing a synchronization processing and a frequency conversion processing, etc., an F.M. detection part 73 outputting the composite signal including an L(left signal)+R(right signal) component signal, an L-R component signal and a pilot signal (signal for determining a stereo signal), a stereo demodulation circuit 74 demodulating the composite signal into a stereo right signal and a stereo left signal and a separation adjustment circuit 75 that is provided at the former stage of the stereo demodulation circuit 74 and adjusts the intensity ratio between an L+R component signal and an L-R component signal in order

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to increase the separation degree (separation) between stereo signals.

The separation adjustment circuit 75 comprises a capacitor 76 for cutting a direct current component, a capacitor 77, a variable resistance 78, a resistance 79, a buffer amplifier 80 and a resistance 81. This circuit adjusts the intensity of the L+R component signal by changing a resistance value of the variable resistance 78. Meanwhile, the capacitors 76 and 77, the variable resistance 78 and the resistance 79 are external components that are not configured on an IC chip.

The intensity of the L+R component signal that is outputted from the F.M. detection part 73 receives the influence of the variable resistance 78 and the resistances 79 and 81. The intensity of the L-R component signal, however, hardly receives the influence of the variable resistance 78 and it receives only the influences of the resistances 79 and 81.

That is, the following equations are satisfied.

Intensity of L+R component \propto resistance value of resistance 81 / (resistance value of variable resistance 78 + resistance value of resistance 79)

Intensity of L-R component \propto resistance value of resistance 81 / resistance value of resistance 79

A frequency band of the L-R component signal is

obtained by centering the frequency of 38kHz. In the case where the L-R component signal passes through the variable resistance 78, the impedance of the capacitor 77 is small and this signal passes through the capacitor 77 without receiving much influence of the variable resistance 78. On the other hand, in the case of the L+R component, the impedance of the capacitor 77 is large and the intensity (signal level) changes according to the resistance value of the variable resistance 78.

By changing the resistance value of the variable resistance 78 in this way, the intensity of the L+R component signal can be changed. Therefore, the intensity ratio between the L+R component signal and the L-R component signal can be adequately adjusted so that it becomes possible to increase the separation degree between stereo signals.

In the conventional stereo receiver 70, however, there is a problem such that many components such as the capacitor 77, the variable resistance 78, etc. are mounted on an IC chip and the cost for mounting the external components increases.

Furthermore, there is another problem such that the mounting area of a printed board increases as the number of external components increases when the stereo receiver 70 is mounted on a printed board.

In addition, it is conceivable that the variable resistance 78 includes, for example, a trimmer resistance, etc. In the production line or the adjustment line of the stereo receiver 70, the resistance value is adjusted by adjusting the trimmer resistance using a driver. In this way, the adjustment of the resistance value of the variable resistance 78 is carried out by an adjustment operator so that the adjustment cannot work well. Therefore, it sometimes takes a long time to implement this adjustment.

Thereupon, the object of the present invention is to offer a separation adjustment circuit where a few external components are mounted and the intensity ratio between composite signals can be easily adjusted, in consideration of the above-mentioned problems.

Disclosure of Invention

In the present invention for solving the above-mentioned problems, the following configuration is adopted.

That is, a separation adjustment circuit for adjusting an intensity ratio between a sum signal and a difference signal in a stereo composite signal and for increasing a separation degree between a stereo right signal and a stereo left signal, comprises a sum signal

retrieving unit retrieving a sum signal from the stereo composite signal; a difference signal retrieving unit retrieving a difference signal from the stereo composite signal; a mixing unit mixing the sum signal and the difference signal, thereby obtaining a stereo right signal and a stereo left signal; a first adjustment unit adjusting a current amount that flows in the sum signal retrieving unit or the difference signal retrieving unit and adjusting an intensity of the sum signal or an intensity of the difference signal; and a generation unit generating a control signal for controlling an adjustment operation of the first adjustment unit.

The sum signal is a signal that shows an L+R component signal obtained by adding the stereo right signal and the stereo left signal. The difference signal is a signal showing an L-R component signal that is the difference between the stereo right signal and the stereo left signal.

The sum signal retrieving unit is, for example, a current mirror circuit for retrieving a sum signal from the stereo composite signal that is inputted into a differential amplifier. Similarly, the difference signal retrieving unit is, for example, a current mirror circuit for retrieving a difference signal from the stereo composite signal.

The mixing unit is, for example, a mixer circuit for mixing the sum signal and the difference signal, thereby obtaining a stereo right signal and a stereo left signal. A stereo demodulation function is implemented by the sum signal retrieving unit, the difference signal retrieving unit and the mixing unit.

The first adjustment unit is, for example, a transistor on the output side for configuring the current mirror circuit. An intensity of the sum signal or the difference signal is adjusted by adjusting the current amount of a transistor on the side of this output so that the separation degree between a stereo right signal and a stereo left signal can be increased. In this way, the number of external components for adjusting an intensity of the sum signal or the difference signal, which are required for the conventional stereo receiver can be decreased. Therefore, it becomes possible to decrease the mounting area of a printed board.

Since the operation of the first adjustment unit is controlled based on the control signal generated by the generation unit, the intensity of the sum signal or the difference signal can be easily adjusted and the separation degree between a stereo right signal and a stereo left signal can be increased, without a manual operation.

In the separation adjustment circuit, the first adjustment unit comprises a plurality of transistors and a selection unit selecting the transistors based on the control signal. This first adjustment unit may
5 adjust an intensity of the sum signal or the difference signal based on the total current amount of the transistors that are selected by the selection unit.

The selection unit is, for example, a switch and this switch is connected to each transistor. By adjusting
10 a current amount that flows in the current mirror circuit by controlling an ON operation or OFF operation of the switch on the basis of the control signal, the switch can adjust the intensity ratio between a sum signal and a difference signal. Therefore, it becomes possible to
15 increase the separation degree between a stereo right signal and a stereo left signal.

The separation adjustment circuit comprises a resistance that is connected to an output stage of the separation adjustment circuit and a second adjustment
20 unit being connected to the resistance in parallel and adjusting a current amount flowing in the resistance. The second adjustment unit may adjust a current amount based on a current amount adjusted by the first adjustment unit.

25 Thus, the DC bias at an output of the separation

adjustment circuit can be also adjusted in the first adjustment unit according to the intensity adjustment of the sum signal or the difference signal. Therefore, it becomes possible to set this DC bias to a predetermined DC bias that does not distort an output signal.

Additionally, the separation adjustment circuit is configured in such a way that the control signal is generated based on the separation degree between a stereo right signal and a stereo left signal that are outputted from the separation adjustment circuit.

Thus, it becomes possible to increase the reliability of the control signal.

Brief Description of the Drawings

The present invention is further clarified if both the detailed explanation that is described later and the attachment drawings are referred to.

Fig. 1 shows a conventional stereo receiver;

Fig. 2 shows a stereo receiver that is a preferred embodiment of the present invention;

Fig. 3 shows the circuit configuration of a separation adjustment circuit;

Fig. 4 shows the concrete examples of a current mirror circuit of a broken-line part C of Fig. 3;

Fig. 5 shows the configuration of the separation

adjustment circuits of another preferred embodiment;
and

Fig. 6 shows the configuration of the separation
adjustment circuits of still another preferred
5 embodiment.

Best Mode for Carrying Out the Invention

The following is the detailed explanation of the
present invention in reference to the drawings.

10 Fig. 2 shows the stereo receiver that is a preferred
embodiment of the present invention.

As shown in Fig. 2, a stereo receiver 10 comprises
an antenna 11, a front end part 12 for implementing a
synchronization processing and a frequency conversion
15 processing, etc., an F.M. detection part 13 outputting
the composite signal including an L (left signal) + R (right
signal) component signal, an L-R component signal and
a pilot signal (signal for determining a stereo signal)
and a separation adjustment circuit 14 having both a
20 stereo demodulation function of demodulating the
composite signal into a stereo right signal and a stereo
left signal and a separation adjustment function of
adjusting the intensity ratio between the L+R component
signal and the L-R component signal in order to increase
25 the separation degree (separation) between the stereo

signals.

At the former stage of the separation adjustment circuit 14, a resistance 15 for supplying a reference voltage in order to adjust the DC bias of a reception
5 signal, a buffer amplifier 16 and a capacitor 17 for cutting a direct current component as an external component, are provided.

Next, the separation adjustment circuit 14 is explained in detail.

10 Fig. 3 shows the circuit configuration of the separation adjustment circuit 14.

At first, a composite signal and a DC reference voltage are inputted into a differential amplifier that includes a P channel MOS transistor 20. Then, the
15 composite signal that is inputted into the differential amplifier is distributed to a broken line frame A and a broken line frame B by the current mirror circuit (sum signal retrieving unit) that includes N channel MOS transistors 21 and 22 and another current mirror circuit
20 (difference signal retrieving unit) that includes transistors 21 and 23. A signal that is distributed to the broken line part A expresses an L+R component signal while a signal that is distributed to the broken line part B shows an L-R component signal. The L-R component
25 signal is inputted into the mixer circuit (mixing unit)

including a transistor 24 and then a 38kHz component signal is removed. And, in the mixer circuit, an L-R component signal obtained by removing the 38kHz component signal and an L+R component signal are mixed (sum or
5 difference computation) so that a stereo right signal (R signal) and a stereo left signal (L signal) are obtained.

Then, in the separation adjustment circuit 14 of the preferred embodiment, the current amount of a current
10 that flows in a current mirror circuit including the transistors 21 and 23, that is, the transistor 23 (first adjustment unit) of the broken line part B is adjusted by a control signal generated by the control circuit 25 (generation unit). By changing the current value that
15 flows in the transistor 23 in this way, the intensity of the L-R component signal is adjusted so that the intensity ratio between the L+R component signal and the L-R component signal can be adjusted. As a result, it becomes possible to increase the separation degree
20 between the L signal and the R signal.

The control signal that is generated by the control circuit 25 is the digital signal of an optional bit number and this signal controls the ON operation or OFF operation of a current amount adjustment switch that is described
25 later.

Fig. 4 shows the concrete example of a current mirror circuit of the broken line part C of Fig. 3. Meanwhile, it is assumed that a current mirror circuit including the transistors 21 and 23 outside the broken line part C has also the same configuration. Furthermore, the same control signal is supplied to two transistors 23 from the control circuit 25 and they function in the same way.

A current mirror circuit 30 as shown in Fig. 4A includes a plurality of transistors 23 (23-1, 23-2, ..., 23-n) and a switch 31 (selection unit) that is connected to a drain of each transistor 23. The ON operation or the OFF operation of each switch 31 is controlled based on a control signal that is outputted from the control circuit 25. Meanwhile, the switch 31 includes a semiconductor switching element.

According to the selected switch 31, the current value of the current that flows in the current mirror circuit 30 changes and the intensity of the L-R component signal is adjusted. In other words, as the number of the switches 31 that become ON increases, the current amount that flows in a contact point D increases. Accordingly, the L-R component signal with a strong intensity is inputted into the mixer circuit. When the number of the switches 31 is small, on the contrary,

the current amount that flows in the contact point D decreases and the L-R component signal with a weak intensity is inputted into the mixer circuit. By adjusting the intensity of the L-R component signal based on the number of the switches 31 that are ON in this way, the intensity ratio between the L+R component signal and the L-R component signal can be adjusted. Therefore, it becomes possible to increase the separation degree between an L signal and an R signal.

A current mirror circuit 32 of another example as shown in Fig. 4B includes a plurality of transistors 23 (23-1, 23-2, ... , 23-n) and the switch 31 that is connected to a gate of each transistor 23. The ON operation or the OFF operation of each switch 31 is controlled based on a control signal that is generated by the control circuit 25. Since the current value of a current that flows in the current mirror circuit 32 changes according to the number of the selected switches 31 in the same way as in Fig. 4A. Therefore, the intensity of the L-R component signal is adjusted in accordance with the change.

The control signal that is generated by the control circuit 25 is generated based on the separation degree between the stereo right signal and the stereo left signal that are outputted. That is, for example, in the case

where a separation degree between the stereo right signal and the stereo left signal is low and an intensity of the L-R component signal is higher than the intensity of the L+R component signal, the control circuit 25
5 generates a control signal for decreasing the number of the switches 31 that are ON. Furthermore, the number of the switches 31 at this time is adjusted in such a way that the intensity of the L+R component signal becomes the same as the intensity of the L-R component signal.
10 In this way, the current amount that flows in a mixer circuit is decreased and the intensity of the L+R component signal becomes the same as the intensity of the L-R component signal. Therefore, it becomes possible to increase the separation degree between the stereo
15 right signal and the stereo left signal.

Furthermore, it is possible to change the size of each transistor 23 of the current mirror circuits 30 or 32 and to optionally select the transistor 23 using the switch 31. By changing each size of the transistor
20 23 of the current mirror circuit 30 or 32 in this way, it becomes possible to set to an optional value, the current amount of the current that flows in the current mirror circuit of the broken-line part C, according to the combination of the selected transistors 23.

25 The following is the explanation of the

configuration of the separation adjustment circuit in another preferred embodiment. The separation adjustment circuit 14 is configured to change the current amount of an L-R component for separation adjustment. By
5 changing the current amount of this L-R component, the DC bias component of the L signal and the R signal that are output signals sometimes change. For example, in the case where the current amount of the L-R component signal is adjusted to be increased, the DC bias of the
10 L signal and the R signal that are outputted from the separation adjustment circuit 14 increases. Accordingly, distortion sometimes occurs on the L signal and the R signal.

Fig. 5 shows a separation adjustment circuit for
15 not generating distortion on the outputted L signal and R signal. In Fig. 5, the same constituent elements as those shown in Fig. 3 indicate the same articles so that the explanations are omitted.

In a separation adjustment circuit 40 shown in Fig.
20 5, a current mirror circuit that includes a transistor 41 is connected to an output part of the separation adjustment circuit 14 of Fig. 3 and both a resistance 42 and a fixed current source 43 (second adjustment unit) that is connected to the resistance 42 in parallel are
25 connected to the output stage of this current mirror

circuit. In addition, the other terminal of the resistance 42 and that of the current source 43 are connected to ground.

5 The current amount of the fixed current source 43 is changed by the control signal of the control circuit 25 based on the intensity of an L-R component signal and the changed current amount is adjusted to a predetermined DC bias in such a way that the output signal does not generate distortion.

10 By changing the current amount of the fixed current source 43 based on the intensity of the L-R component signal in this way, the current amount of a current that flows in the resistance 42 can be changed. Therefore, for example, even if the current amount is adjusted to
15 increase the intensity of the L-R component signal, the output can be suppressed not to exceed the fixed DC bias and the distortion of an output signal can be avoided.

 In the changing method of a current amount of the fixed current source 43, it is possible that the current
20 that flows in the resistance 42 is adjusted by connecting a fixed current source on a drain side of the transistor 23 and by selecting the transistor 23 using the switch 31, in a current mirror circuit which includes the transistor 21, a plurality of the transistors 23 and
25 the switch 31 that is connected to each transistor 23

as shown in Fig. 4. In other words, a method of changing a current amount by connecting the fixed current source 43 to the current mirror circuit which includes a plurality of transistors and by selecting the number
5 of the transistors on the output side using the switch, etc. is conceivable.

Meanwhile, the resistance 42 and the fixed current source 43 provided at the output stage of the separation adjustment circuit 40 as shown in Fig. 5 may be configured
10 not to be connected to the current mirror circuit.

Fig. 6 shows a separation adjustment circuit configured in such a way that it adjusts the current amount of an output stage without being connected to the current mirror circuit.

15 As shown in Fig. 6, the resistance 42 and the fixed current source 43 that is connected to the resistance 42 in parallel are connected to the output stage of the separation adjustment circuit 50. The other terminal of the resistance 42 and that of the fixed current source
20 43 are connected to a power source (VDD). The current value that flows in the fixed current source 43 is changed on the basis of the control signal that is outputted from the control circuit 25 in the same way as in Fig.
5.

25 Even if the separation adjustment circuit is

configured to adjust the current amount that flows in the resistance 42 at the output stage without being connected to the current mirror circuit, the DC bias of an output signal can be controlled at a predetermined value.

Furthermore, a variable resistance may be provided instead of the transistor 23 of the separation adjustment circuit 14 of Fig. 3.

Both the stereo demodulation function of implementing the sum or difference computation between the L-R component signal from which the 38kHz component signal is removed and the L+R component signal and the separation adjustment function of adjusting the intensity ratio between the L-R component signal and the L+R component signal can be realized by adjusting the bias current (current amount of the current mirror circuit) of a mixer circuit having the stereo demodulation function.

Since the number of the external components such as a capacitor 77 that is indispensable for a conventional stereo receiver 70 can be decreased, it becomes possible to decrease the mounting area of a printed board.

In addition, it becomes possible to increase the separation degree between a right signal and a left signal without manual operations, which is realized by an

electric control based on the control signal that is generated by the generation unit.

Furthermore, a variable resistance 78, etc. that are required at the conventional stereo receiver 70 in Fig. 1 can be omitted using the separation adjustment circuit of the preferred embodiment of the present invention so that a reception signal does not receive the influence of the impedance based on the resistance. Therefore, it becomes possible to decrease the capacity of a capacitor 76 for cutting the DC component of the reception signal. In this way, the capacitor 76 for cutting a DC component (capacitor 17 in the preferred embodiment of the present invention) having a small capacity, in other words, the capacitor having a small size can be mounted. Accordingly, it becomes possible to further decrease the mounting area of a printed board.

Additionally, the above-mentioned separation adjustment circuit is configured to adjust the current amount of the L-R component but this circuit may be also configured to adjust the current amount of the L+R component.

According to the separation adjustment circuit of the present invention, the current amount that flows in the retrieving unit used when a sum signal or a difference signal is retrieved from a stereo composite

signal is adjusted based on the control signal generated by the generation unit so that these configurations can be realized on an IC chip, etc. Therefore, the number of the external components for the separation adjustment
5 that are required in a conventional stereo receiver can be decreased and accordingly the mounting area of a printed board can be also decreased.

Furthermore, since the intensity ratio between a sum signal and a difference signal are adjusted on the
10 basis of the control signal that is generated by the generation unit, it becomes possible to increase the separation degree between a right signal and a left signal without manual operations.